International Journal of Agricultural
Science and Research (IJASR)
ISSN (P): 2250-0057; ISSN (E): 2321-0087
Vol. 7, Issue 5, Oct 2017, 395-406


TRANS STELLAR
•Journal Publications •Research Consultancy

# QUALITY AND SHELF LIFE OF GANESH POMEGRANATE ARILS AS AFFECTED BY DIFFERENT PACKAGING MATERIAL AND STORAGE CONDITIONS

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***ABSTRACT***

***Different packaging material was used for packaging pomegranate arils and was evaluated for shelf life and quality parameters at different storage temperatures. Arils packed in PPMM ($P_3$) recorded with high anthocyanin content (24.03 mg 100g$^{-1}$) and β-carotene content (18.26 µg 100g$^{-1}$) and high organoleptic score for colour (6.17), taste (6.00), flavour (6.25) and overall acceptability (6.08) with less microbial count (2.33 ×10$^8$CFU/ml) was observed. With respect to storage temperatures, arils stored at 1°C ($S_1$) recorded with high anthocyanin content (24.56 mg 100g$^{-1}$) and β-carotene content (21.91 µg 100g$^{-1}$) and high organoleptic score for colour (7.44), taste (7.89), flavour (7.22) and overall acceptability (6.78) with lowest microbial count (1.44 ×10$^8$CFU/ml). The interaction effect of packing material and storage temperatures, revealed that high anthocyanin content (25.05 mg 100g$^{-1}$) and β-carotene content (23.23 µg 100g$^{-1}$) and the highest organoleptic score for aril colour (8.00), taste (8.33), flavour (7.33) and overall acceptability (7.33) with lowest microbial count (1.00 ×10$^8$CFU/ml) were recorded in the PPMM + 1°C ($P_3S_1$).***

***KEYWORDS: Arils, Packaging Material & Storage Temperatures***

**Received**: Aug 26, 2017; **Accepted**: Sep 15, 2017; **Published**: Sep 28, 2017; **Paper Id**.: IJASROCT201747

Original Article

## INTRODUCTION

In India, only about 2 percent of the fruits and vegetables are processed into value added products. Pomegranate being rich in nutritive and therapeutic values, provides vast opportunity for its economic utilization like fresh juice, aril packs (dried and fresh), jelly, tea, wine and seed oil through processing and non-food usage of dyes, inks, essences and chemicals for tannin industry. Pomegranate (*Punica granatum* L.) is an ancient plant, belonging to the family Lythraceae. Pomegranate fruit and its juice are well known for its antioxidant capacity and hence becoming popular, to prevent cancers of different tissues and organs. This has led farmers to diversify their cropping system with pomegranate cultivation, for domestic consumption and export. Because, of its adaptability

to varied climatic and soil conditions, it is well suited to grow in tropical and sub-tropical regions of the country. Globally, at present, India is one of the leading countries in pomegranate acreage (3.0 lakh ha) and production of 2.5 million tonnes (Patil *et al.* 2014) and the crop is commercially grown in the states of Maharashtra, Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu, and to some extent in some other states of the country also. The edible portion is an excellent dietary source, contains a significant proportion of phenolic compounds, antioxidants, anthocyanis, organic acids, soluble solids, polysaccharides, vitamins, fatty acids and mineral elements of nutritional significance (Fadavi et al. 2006). In spite of these numerous health benefits, pomegranate consumption is still limited, due to the difficulties of removing of arils from the fruit and the irritation of phenolic metabolites, which stain the hands during preparation of seeds (Gil *et al*., 1996b). Minimally, processing of pomegranate into arils can bring about the convenience, for food services and consumers (Ersan *et al.,* 2010). Eventhough, minimal processing of this fruit may bring convenience, its quality may be reduced, as a result of an increase in respiration rate.

## MATERIAL AND METHODS

The experiment was conducted at Post-Harvest Technology Laboratory, College of Horticulture (COH), Anantharajupet, YSR Kadapa district, Andhra Pradesh, during the year, 2015. The fruits of pomegranate varieties, namely, Bhagwa used in the experiment were obtained from AICRP centre on Arid Zone fruits, Horticultural Research Station, Rekulakunta, Ananthapuramu district, Andhra Pradesh. The experiment was conducted in a completely randomized design, replicated thrice with 3 packaging materials viz., PESP ($P_1$), PETP ($P_2$) and PPMM ($P_3$) and storage temperatures $S_1$ (1°C), $S_2$ (4°C), $S_3$ (8°C) and $S_4$ (room temperature).

### Anthocyanin

The procedure outlined by Harborne (1973) was used for analyzing anthocyanin content (mg $100g^{-1}$), in pomegranate arils. One gram of pomegranate arils was macerated in one ml of methanol, containing one percent hydrochloric acid. The content was kept overnight at a 0°C temperature in a deep freezer. The absorbance of the red colored solution was recorded at 530 nm, on a spectrophotometer. Anthocyanin content was expressed as absorption units at 530 nm per gram of fresh arils.

### β-Carotene

The ß - carotene content of pomegranate arils was estimated by using the methodology of Srivastava and Kumar (2003). β-carotene was extracted from the sample, by crushing one gram of sample with 10 ml acetone and adding crystals of anhydrous sodium sulphate. The supernatant was decanted and collected in a beaker. The process was repeated twice. Ten ml of petroleum ether was added and mixed thoroughly. The content was transferred into a separating funnel and two layers were separated out, on standing solution. Lower layer was discarded and upper layer was collected, and volume was made upto20 ml with petroleum ether. The optical density was recorded at 452 nm, using petroleum ether as blank.

### Moulds and Yeasts

For microbial count estimation, 28g of Nutrient Agar (NA) was suspended in a 1000 ml of distilled water in one beaker, and 39g of Potato Dextrose Agar (PDA) in 1000 ml of distilled water in another beaker, and both of them heated to boiling, in order to dissolve the medium completely. After that, sterilization was done by autoclaving at 15 lbs pressure (121°C), for 15 minutes. Mixed media were poured in Petri-plates, in the laminar air flow chamber. The test tubes in the

test tube stand were added, with 9 ml distilled water in each test tube. After that, the test tubes were sterilized at 15 psi and 121°C in autoclave. One gram of aril juice was added in one test tube and labeled as 10. From this test tube, 1 ml of sample was taken to another test tube, and labeled as $10^{-1}$. This step is repeated up to $10^{-3}$. 100 micro litre samples were taken and added aseptically with the help of micro pipette, in three different NA and PDA plates, and spread with the help of a spreader. These plates were kept in BOD incubator (PDA plates at 30°C and NA plates at 25°C) for incubation. Count for CFU was done after 48 hours.

## SENSORY EVALUATION

The stored arils of pomegranate were examined for their sensory qualities, by assessing the colour, flavour, texture and overall acceptability. Sensory evaluation was carried out by a panel of 5 judges, and the rating was done with a score of 9 points Hedonic scale, as proposed by Amerine *et al.* 1965.

## STATISTICAL ANALYSIS

The data collected were analyzed statistically using factorial completely randomized design, as per the procedure outlined by Panse and Sukhatme (1985), and valid conclusions were drawn, only on significant differences between treatments mean at 0.05 percent, level of significance.

## RESULTS AND DISCUSSIONS

### Anthocyanin Content (mg $100g^{-1}$)

There were significant differences in anthocyanin (mg $100g^{-1}$) content of arils,packed with different packing material and stored at different storage temperatures (Table 1). Among packing materials, arils packed in PPMM ($P_3$) recorded the highest anthocyanin content (mg $100g^{-1}$) (26.14, 25.65, 25.00and 24.03) while, arils packed in PETP ($P_2$) recorded the lowest anthocyanin (mg $100g^{-1}$) content (25.45, 24.53, 23.91and 23.12). The data recorded on anthocyanin content (mg $100g^{-1}$), revealed higher values in arils stored at 1°C ($S_1$) (26.58, 26.32, 25.62 and 24.56) and lower values in arils stored at room temperature ($S_4$) (24.01, 23.31, 22.84 and 22.61). These results are in agreement with the findings of Artes *et al.* (2000) and Ayhan and Esturk (2009), in pomegranate cv. Hicaznar. The interaction between packing material and storage temperatures had a significant effect on anthocyanin content (mg $100g^{-1}$) of arils. Significantly, the highest anthocyanin (mg $100g^{-1}$) content was recorded in PPMM + 1°C ($P_3S_1$) (26.78, 26.61 and 26.04), and lowest anthocyanin content (mg $100g^{-1}$) in PETP + room temperature ($P_2S_4$) (23.32, 22.88 and 22.54), on $4^{th}$, $8^{th}$ and the 12th day of storage. No significant difference was found on the interaction effect of packing material and storage temperature, with respect to anthocyanin content in arils on $16^{th}$ day of storage. A general trend of decrease in the total anthocyanin content of arils was observed, as the storage period advanced for all treatments. The decrease in anthocyanin content during storage might be due to oxidative activity of Polyphenol Oxidase (Vamos-Vigyazo, 1981).

### β-Carotene Content (µg $100g^{-1}$)

It is observed from the data presented in Table 2 that, there was a significant influence of packing material and storage temperatures on β-carotene content (µg $100g^{-1}$) of arils. The arils packed in $P_3$ (PPMM) recorded significantly highest β-carotene content (µg $100g^{-1}$) (23.77, 21.16, 20.30 and18.26 in Ganesh) whereas, PETP ($P_2$) recorded the lowest beta-carotene content (µg $100g^{-1}$) 22.45, 19.89, 18.17 and 16.79, during the storage period. Maximum β-carotene content (µg $100g^{-1}$) was observed in arils, stored at 1°C ($S_1$) (28.50, 26.05, 24.20 and 21.91) while, minimum β-carotene content

(μg $100g^{-1}$) was observed in arils stored at room temperature ($S_4$) (17.58, 16.12, 14.63 and 13.69). The significant interaction effect of packing material and storage temperature on β-carotene content (μg $100g^{-1}$) of arils, was observed on $4^{th}$ and $16^{th}$ day of storage. The highest β-carotene content (μg $100g^{-1}$) was noticed in PPMM+1°C ($P_3S_1$) (29.41 and 23.23) and lowest in PETP + room temperature ($P_2S_4$) (16.15 and 13.41). There were no significant differences observed on the $8^{th}$ and the $12^{th}$ day of storage, in arils. There was a reduction in β-carotene content of arils, irrespective of packing, storage temperature and interaction effect, throughout the storage period, as also reported by Pilon (2006) in Carrot and Green pepper. This may be due to high solubility of β-carotene content in water, that favour large pigment loss, due to exposure of arils surface to water, that is stored during the physiological process like respiration.

**Moulds and Yeast (×$10^8$CFU/ml)**

The data presented in Table 3, showed significant influence of packing material and storage temperatures, on the growth of moulds and yeast on arils. The lowest microbial load (×$10^8$CFU/ml) was observed in arils, packed in PPMM ($P_3$) (0.17, 0.58, 1.25 and 2.33) while, highest microbial load (×$10^8$CFU/ml) was recorded in arils packed in PETP ($P_2$) (0.83, 1.92, 2.67 and 3.58). With regard to arils stored at different temperatures, no visual detection of mould growth was seen at $S_1$ (1°C), $S_2$ (4°C) and $S_3$ (8°C) whereas, maximum microbial growth was observed at room temperature ($S_4$) (1.78) on $4^{th}$ day of storage. On the 8th day of storage, there was no visual mould growth seen at $S_1$ (1°C) while, minimum microbial count (×$10^8$CFU/ml) was observed on 8°C ($S_3$) (0.33) and maximum count (×$10^8$CFU/ml) in room temperature ($S_4$) (3.00). The lowest microbial load (×$10^8$CFU/ml) was observed at 1°C ($S_1$) (0.67 and 1.44) and highest microbial load (×$10^8$CFU/ml) was observed at room temperature ($S_4$) (4.11 and 5.11) during the 12th and 16th day of storage. The importance of storage temperature during storage of arils have been emphasized by many researchers who reported low temperatures (0-5°C) at modified atmosphere conditions was effective to reduce respiration rate, enzymatic processes and microbial activity (Gil *et al.* 1996 b, Kader, 2002 and Nicola *et al.* 2009). Significant differences were observed in the interaction effect between packing material and storage temperatures on microbial load (×$10^8$CFU/ml) of arils. On $4^{th}$day of storage, there was no visual mould growth in $P_1S_1$, $P_2S_1$, $P_3S_1$, $P_1S_2$, $P_2S_2$, $P_3S_2$, $P_1S_3$, $P_2S_3$ and $P_3S_3$ whereas, maximum microbial load (×$10^8$CFU/ml) was observed in $P_2S_4$ (3.33). On the 8th day of storage, there was no visual mould growth in $P_1S_1$, $P_2S_1$, $P_3S_1$, $P_1S_2$ and $P_3S_2$ while, maximum microbial count (×$10^8$CFU/ml) was observed in $P_2S_4$ (4.33). On $12^{th}$ day, significant difference was observed in the interaction effect on microbial count (×$10^8$CFU/ml) of arils. Minimum microbial count (×$10^8$CFU/ml) was observed in PPMM + 1°C ($P_3S_1$) (0.33) and maximum in PETP and room temperature ($P_2S_4$) (4.67). On the 16th day, there was no significant difference was observed in the interaction effect of Eris. Gil *et al.* (1996), Kader (2002) and Nicola *et al.* (2009) reported that no visual detection of mould growth was seen in 'Arakta' and 'Bhagwa' arils stored at 1°C after 14 days. Higher storage temperature affected the proximate composition, physico-chemical attributes and bioactive components negatively. This study agrees with other researchers and advises pomegranate producers and retailers that the cold chain should be maintained at low (0-5°C) storage temperature and 95% RH for optimal quality of minimally processed arils of pomegranate. Soliva and Martin Belloso (2003) and Caleb *et al.* (2013) reported that, the physico-chemical properties of pomegranate arils such as titratable acidity and cultivar have an important effect on microbial growth and shelf life of fresh cut arils. Gill *et al.* (1996) used the lowest respiration rate as one of the measures to recommend 1°C and Modular Mate pack for best quality preservation of pomegranate arils. Storage of arils under optimal MA has been shown to reduce the risk of enterobacteria and lactic acid bacteria, as well as moulds and yeast counts (Sepulveda *et al.* 2000 and Lopez-Rubira *et al.* 2005 in pomegranate). Furthermore, since the pomegranate arils store at lower temperature, the risk of microbial proliferation was reduced. According to Artes *et al.*

(2000a, b), higher levels of decay were mainly due to *Penicillium* spp. Similarly, Lopez-Rubira *et al.* (2005) observed a low count of micro-aerophilic lactic acid bacteria after 10 days of aril storage, without any trace of fermentative metabolism.

## ORGANOLEPTIC EVALUATION (9 POINT HEDONIC SCALE)

### Colour

There was a significant effect of packing material and storage temperatures on the sensory qualities of arils during the entire storage period (Table 4). Significantly, the highest colour score was recorded in arils, packed in PPMM ($P_3$) (7.58, 7.50, 6.83 and 6.17) and the lowest colour score was recorded in arils packed in PETP ($P_2$) (6.92, 6.58, 6.17 and 5.50), during the storage period of 16 days. In case of storage temperatures, maximum colour score was recorded in arils stored at 1°C ($S_1$) (8.44, 8.22, 7.67 and 7.44) and the minimum colour score was recorded in arils stored at room temperature ($S_4$) (4.78, 4.44, 3.89 and 2.78). Similar observation to this finding was also reported by Nanda *et al.* (2001) in pomegranate, when fruits were packed in shrink film.

### Taste

The taste of arils differed significantly with respect to packing material and storage temperatures (Table 5). The maximum rating for aril taste was observed in PPMM ($P_3$) (6.42, 6.33, 6.08 and 6.00) and minimum in PETP ($P_2$) (5.92, 5.83, 5.58 and 5.50) during the storage period of sixteen days. The highest score for aril taste was recorded at 1°C ($S_1$) (8.67, 8.44, 8.22 and 7.89) whereas, lowest score for aril taste was recorded at room temperature ($S_3$) (7.89, 7.33, 7.33 and 7.33). There were no significant differences observed on the interaction effects of sensory attributes of arils packed with different packing material and storage temperatures throughout the storage period of sixteen days. During the storage period, there was a decreasing trend in organoleptic score for taste of arils was due to fluctuations in acids, pH and sugar/acid ratio as reported by Malundo *et al.* (1991) in mango.

### Flavour

Flavour of the arils packed with different packing materials and stored at different storage temperatures was found to be significant (Table 6). The minimum off flavor score was observed in PPMM ($P_3$) (7.42, 7.25, 6.75 and 6.25) whereas, maximum off flavor score was observed in PETP ($P_2$) (6.67, 6.42, 6.17 and 5.75) packed arils. Concerned to different temperatures, the lowest off flavor score was observed at 1°C ($S_1$) (8.11, 8.11, 7.56 and 7.22) while, highest off flavor score was observed at room temperature ($S_4$) (4.78, 4.11, 3.44 and 3.22). There were no significant differences observed on the interaction effects of sensory attributes of arils packed with different packing material and storage temperatures throughout the storage period of sixteen days. The maximum score for good flavor of arils appeared to be due to reduced rate of respiration and moisture loss from the arils and also less microbial contamination in the packing materials reported by Nanda *et al.* (2001) in pomegranate.

### Overall Acceptability

It is evident from the data presented in Table 7 that the overall acceptability of arils varied significantly and the results were found significant. The highest overall acceptability of arils was recorded in PPMM ($P_3$) (7.58, 6.92, 6.75 and 6.08) and lowest overall acceptability of arils was recorded in PETP ($P_2$) (6.58, 6.00, 5.92 and 5.33) during the storage period. With respect to storage temperatures, the maximum overall acceptability score of arils was recorded at 1°C ($S_1$) (8.44, 7.78, 7.33 and 6.78) and minimum overall acceptability score was observed at room temperature ($S_4$) (4.00, 3.44,

3.44 and 3.33). The better organoleptic score for arils stored packed in PPMM at lower temperatures could be attributed to the maximum retention of chemical constituents in proper proportions. Similar observations were reported by Nanda *et al.* (2001) in pomegranate and Rathod *et al.* (2011) in carambola fruits. The interaction effect of packing material and storage temperatures on the sensory attributes of arils was non-significant, throughout the storage period. Maintaining the nutritional and organoleptic quality of pomegranate arils is a major challenge, because extracted arils deteriorate in colour, taste, flavor and overall acceptability and a reduction in shelf-life (Gil *et al.* 1996b). This is due to active metabolic processes by endogenous enzymatic activity and enhanced respiration rate as opined by Rolle and Chism (1987) in fruits and vegetables, and Ergun (2009) in Pomegranate.

## CONCLUSIONS

Among different packaging materials and storage temperatures used in the study, the PPMM and 1°C was adjudged best, for maintaining nutritional quality and shelf life of arils of pomegranate cv. Ganesh, upto 16 days during storage.

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## APPENDICES

**Table 1: Anthocyanin Content (mg $100g^{-1}$) of Arils of Pomegranate cv. Ganesh as Influenced by different Packing Material and Storage Temperatures**

| Anthocyanin Content (mg $100g^{-1}$) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage Period (days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 27.49 | 26.61 | 26.34 | 26.78 | 26.58 | 26.51 | 25.83 | 26.61 | 26.32 | 25.73 | 25.08 | 26.04 | 25.62 | 24.75 | 23.90 | 25.05 | 24.56 |
| $S_2$ | 27.49 | 26.48 | 26.31 | 26.68 | 26.49 | 26.24 | 25.29 | 26.34 | 25.96 | 25.53 | 24.47 | 25.76 | 25.25 | 24.00 | 23.49 | 24.34 | 23.94 |
| $S_3$ | 27.49 | 26.00 | 25.83 | 26.14 | 25.99 | 25.56 | 24.13 | 25.73 | 25.14 | 24.68 | 23.56 | 24.98 | 24.41 | 23.52 | 22.88 | 23.79 | 23.40 |
| $S_4$ | 27.49 | 23.76 | 23.32 | 24.95 | 24.01 | 23.12 | 22.88 | 23.93 | 23.31 | 22.78 | 22.54 | 23.22 | 22.84 | 22.64 | 22.23 | 22.95 | 22.61 |
| Mean | 27.49 | 25.71 | 25.45 | 26.14 | | 25.36 | 24.53 | 25.65 | | 24.68 | 23.91 | 25.00 | | 23.73 | 23.12 | 24.03 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.070 | | 0.205 | | 0.050 | | 0.146 | | 0.045 | | 0.132 | | 0.091 | | 0.265 | |
| S | | 0.081 | | 0.236 | | 0.058 | | 0.168 | | 0.052 | | 0.152 | | 0.105 | | 0.306 | |
| P×S | | 0.140 | | 0.410 | | 0.100 | | 0.292 | | 0.090 | | 0.264 | | 0.182 | | NS | |

**Table 2: Effect of Different Packing Material and Storage Temperatures on β- Carotene Content (μg 100 $g^{-1}$) of Arils of Pomegranate cv. Ganesh**

| β-carotene Content (μg 100 $g^{-1}$) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage Period (days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 30.75 | 27.74 | 28.35 | 29.41 | 28.50 | 26.19 | 25.66 | 26.29 | 26.05 | 23.24 | 22.00 | 27.34 | 24.20 | 22.08 | 20.43 | 23.23 | 21.91 |
| $S_2$ | 30.75 | 23.55 | 23.51 | 23.98 | 23.68 | 20.78 | 19.02 | 21.10 | 20.30 | 19.15 | 18.90 | 19.20 | 19.08 | 18.08 | 16.80 | 18.40 | 17.76 |
| $S_3$ | 30.75 | 22.01 | 21.78 | 22.40 | 22.06 | 19.77 | 19.26 | 20.58 | 19.87 | 18.75 | 17.89 | 18.86 | 18.50 | 16.52 | 16.51 | 17.19 | 16.74 |
| $S_4$ | 30.75 | 17.33 | 16.15 | 19.28 | 17.58 | 16.05 | 15.62 | 16.68 | 16.12 | 14.23 | 13.89 | 15.78 | 14.63 | 13.44 | 13.41 | 14.21 | 13.69 |
| Mean | 30.75 | 22.66 | 22.45 | 23.77 | | 20.70 | 19.89 | 21.16 | | 18.84 | 18.17 | 20.30 | | 17.53 | 16.79 | 18.26 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.20 | | 0.57 | | 0.32 | | 0.93 | | 0.47 | | 1.36 | | 0.16 | | 0.45 | |
| S | | 0.23 | | 0.66 | | 0.37 | | 1.08 | | 0.54 | | 1.58 | | 0.18 | | 0.52 | |
| P×S | | 0.39 | | 1.15 | | 0.64 | | NS | | 0.94 | | NS | | 0.31 | | 0.91 | |

**Table 3: Effect of Different Packing Material and Storage Temperatures on Microbial Count (×10$^8$CFU/ml) of Arils of Pomegranate cv. Ganesh**

| Microbial Count (×10$^8$CFU/ml) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage Period (days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.67 | 1.00 | 0.33 | 0.67 | 1.33 | 2.00 | 1.00 | 1.44 |
| $S_2$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.33 | 1.00 | 1.33 | 0.67 | 1.00 | 1.67 | 2.33 | 1.33 | 1.78 |
| $S_3$ | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 2.33 | 0.67 | 1.33 | 2.00 | 3.67 | 0.67 | 2.11 | 3.33 | 4.33 | 2.00 | 3.22 |
| $S_4$ | 0.00 | 1.33 | 3.33 | 0.67 | 1.78 | 3.00 | 4.33 | 1.67 | 3.00 | 4.33 | 4.67 | 3.33 | 4.11 | 4.67 | 5.67 | 5.00 | 5.11 |
| Mean | 0.00 | 0.33 | 0.83 | 0.17 | | 1.00 | 1.92 | 0.58 | | 2.00 | 2.67 | 1.25 | | 2.75 | 3.58 | 2.33 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.08 | | 0.24 | | 0.13 | | 0.37 | | 0.14 | | 0.42 | | 0.18 | | 0.53 | |
| S | | 0.10 | | 0.28 | | 0.15 | | 0.43 | | 0.17 | | 0.49 | | 0.21 | | 0.61 | |
| P×S | | 0.17 | | 0.49 | | 0.25 | | 0.74 | | 0.29 | | 0.84 | | 0.36 | | NS | |

**Tables 4: Aril Colour of Pomegranate Cv. Ganesh as Influenced By Different Packing Material and Storage Temperatures**

| Aril Colour (organoleptic score) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage period (days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 9.00 | 8.67 | 8.00 | 8.67 | 8.44 | 8.33 | 7.67 | 8.67 | 8.22 | 7.67 | 7.33 | 8.00 | 7.67 | 7.33 | 7.00 | 8.00 | 7.44 |
| $S_2$ | 9.00 | 8.33 | 8.00 | 8.33 | 8.22 | 8.00 | 7.33 | 8.33 | 7.89 | 7.33 | 7.33 | 7.67 | 7.44 | 7.33 | 6.33 | 7.00 | 6.89 |
| $S_3$ | 9.00 | 7.67 | 7.33 | 8.00 | 7.67 | 7.67 | 7.33 | 8.00 | 7.67 | 7.33 | 6.67 | 7.33 | 7.11 | 6.33 | 6.00 | 6.33 | 6.22 |
| $S_4$ | 9.00 | 4.67 | 4.33 | 5.33 | 4.78 | 4.33 | 4.00 | 5.00 | 4.44 | 4.00 | 3.33 | 4.33 | 3.89 | 2.33 | 2.67 | 3.33 | 2.78 |
| Mean | 9.00 | 7.33 | 6.92 | 7.58 | | 7.08 | 6.58 | 7.50 | | 6.58 | 6.17 | 6.83 | | 5.83 | 5.50 | 6.17 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.17 | | 0.49 | | 0.14 | | 0.40 | | 0.15 | | 0.44 | | 0.16 | | 0.47 | |
| S | | 0.19 | | 0.56 | | 0.16 | | 0.46 | | 0.18 | | 0.51 | | 0.18 | | 0.54 | |
| P×S | | 0.33 | | NS | | 0.27 | | NS | | 0.30 | | NS | | 0.32 | | NS | |

**Table 4: Effect of Different Packing Material and Storage Temperatures on Flavour of Arils of Pomegranate cv. Ganesh**

| Flavour of Arils (Organoleptic Score) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage Period (Days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 9.00 | 8.00 | 8.00 | 8.33 | 8.11 | 8.00 | 8.00 | 8.33 | 8.11 | 7.67 | 7.33 | 7.67 | 7.56 | 7.33 | 7.00 | 7.33 | 7.22 |
| $S_2$ | 9.00 | 8.00 | 7.67 | 8.33 | 8.00 | 7.67 | 7.33 | 8.33 | 7.78 | 7.33 | 7.33 | 7.67 | 7.44 | 6.67 | 6.67 | 7.33 | 6.89 |
| $S_3$ | 9.00 | 7.33 | 7.00 | 7.67 | 7.33 | 7.33 | 7.00 | 7.33 | 7.22 | 7.33 | 7.00 | 7.33 | 7.22 | 6.67 | 6.33 | 6.67 | 6.56 |
| $S_4$ | 9.00 | 5.00 | 4.00 | 5.33 | 4.78 | 4.00 | 3.33 | 5.00 | 4.11 | 3.00 | 3.00 | 4.33 | 3.44 | 3.00 | 3.00 | 3.67 | 3.22 |
| Mean | 9.00 | 7.08 | 6.67 | 7.42 | | 6.75 | 6.42 | 7.25 | | 6.33 | 6.17 | 6.75 | | 5.92 | 5.75 | 6.25 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.12 | | 0.34 | | 0.13 | | 0.37 | | 0.14 | | 0.42 | | 0.14 | | 0.42 | |
| S | | 0.14 | | 0.40 | | 0.15 | | 0.43 | | 0.17 | | 0.49 | | 0.17 | | 0.49 | |
| P×S | | 0.24 | | NS | | 0.25 | | NS | | 0.29 | | NS | | 0.29 | | NS | |

**Tables 5: Taste of Arils of Pomegranate Cv. Ganesh as Influenced by Different Packing Material and Storage Temperatures**

| Taste of Arils (Organoleptic Score) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage Period (Days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 9.00 | 8.67 | 8.33 | 9.00 | 8.67 | 8.33 | 8.00 | 8.67 | 8.44 | 8.00 | 8.00 | 8.67 | 8.22 | 7.67 | 7.67 | 8.33 | 7.89 |
| $S_2$ | 9.00 | 8.33 | 7.67 | 8.67 | 8.22 | 8.00 | 7.33 | 8.33 | 8.11 | 8.00 | 7.33 | 8.00 | 7.78 | 8.00 | 7.33 | 8.00 | 7.78 |
| $S_3$ | 9.00 | 8.00 | 7.67 | 8.00 | 7.89 | 7.33 | 7.00 | 7.67 | 7.67 | 7.33 | 7.00 | 7.67 | 7.33 | 7.33 | 7.00 | 7.67 | 7.33 |
| $S_4$ | 9.00 | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* | 0.00* |
| Mean | 9.00 | 6.25 | 5.92 | 6.42 | | 6.00 | 5.83 | 6.33 | | 5.83 | 5.58 | 6.08 | | 5.75 | 5.50 | 6.00 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.12 | | 0.34 | | 0.13 | | 0.37 | | 0.10 | | 0.28 | | 0.12 | | 0.34 | |
| S | | 0.14 | | 0.40 | | 0.15 | | 0.43 | | 0.11 | | 0.32 | | 0.14 | | 0.40 | |
| P×S | | 0.24 | | NS | | 0.25 | | NS | | 0.19 | | NS | | 0.24 | | NS | |

**Table 6: Effect of Different Packing Material and Storage Temperatures on Flavour of Arils of Pomegranate Cv. Ganesh**

| Flavour of Arils (Organoleptic Score) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage Period (Days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 9.00 | 8.00 | 8.00 | 8.33 | 8.11 | 8.00 | 8.00 | 8.33 | 8.11 | 7.67 | 7.33 | 7.67 | 7.56 | 7.33 | 7.00 | 7.33 | 7.22 |
| $S_2$ | 9.00 | 8.00 | 7.67 | 8.33 | 8.00 | 7.67 | 7.33 | 8.33 | 7.78 | 7.33 | 7.33 | 7.67 | 7.44 | 6.67 | 6.67 | 7.33 | 6.89 |
| $S_3$ | 9.00 | 7.33 | 7.00 | 7.67 | 7.33 | 7.33 | 7.00 | 7.33 | 7.22 | 7.33 | 7.00 | 7.33 | 7.22 | 6.67 | 6.33 | 6.67 | 6.56 |
| $S_4$ | 9.00 | 5.00 | 4.00 | 5.33 | 4.78 | 4.00 | 3.33 | 5.00 | 4.11 | 3.00 | 3.00 | 4.33 | 3.44 | 3.00 | 3.00 | 3.67 | 3.22 |
| Mean | 9.00 | 7.08 | 6.67 | 7.42 | | 6.75 | 6.42 | 7.25 | | 6.33 | 6.17 | 6.75 | | 5.92 | 5.75 | 6.25 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.12 | | 0.34 | | 0.13 | | 0.37 | | 0.14 | | 0.42 | | 0.14 | | 0.42 | |
| S | | 0.14 | | 0.40 | | 0.15 | | 0.43 | | 0.17 | | 0.49 | | 0.17 | | 0.49 | |
| P×S | | 0.24 | | NS | | 0.25 | | NS | | 0.29 | | NS | | 0.29 | | NS | |

**Table 7: Effect of Different Packing Material and Storage Temperatures on Overall Acceptability of Arils of Pomegranate Cv.Ganesh**

| Overall acceptability of arils (organoleptic score) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage period (days) | | | | | | | | | | | | | | | | | |
| | 0 | 4 | | | | 8 | | | | 12 | | | | 16 | | | |
| | | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean | $P_1$ | $P_2$ | $P_3$ | Mean |
| $S_1$ | 9.00 | 8.67 | 8.00 | 8.67 | 8.44 | 7.67 | 7.33 | 8.33 | 7.78 | 7.00 | 7.00 | 8.00 | 7.33 | 6.67 | 6.33 | 7.33 | 6.78 |
| $S_2$ | 9.00 | 8.33 | 7.67 | 8.67 | 8.22 | 8.00 | 7.00 | 8.00 | 7.67 | 6.67 | 7.00 | 7.67 | 7.11 | 6.67 | 6.00 | 7.00 | 6.56 |
| $S_3$ | 9.00 | 8.00 | 7.67 | 8.00 | 7.89 | 7.33 | 6.67 | 7.33 | 7.11 | 6.00 | 6.67 | 7.33 | 6.67 | 6.00 | 6.00 | 6.00 | 6.00 |
| $S_4$ | 9.00 | 4.00 | 3.00 | 5.00 | 4.00 | 3.33 | 3.00 | 4.00 | 3.44 | 3.33 | 3.00 | 4.00 | 3.44 | 3.00 | 3.00 | 4.00 | 3.33 |
| Mean | 9.00 | 7.25 | 6.58 | 7.58 | | 6.58 | 6.00 | 6.92 | | 5.75 | 5.92 | 6.75 | | 5.58 | 5.33 | 6.08 | |
| Statistics | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | | S. Em± | | CD@P=0.05 | |
| P | | 0.12 | | 0.34 | | 0.13 | | 0.37 | | 0.11 | | 0.31 | | 0.10 | | 0.28 | |
| S | | 0.14 | | 0.40 | | 0.15 | | 0.43 | | 0.12 | | 0.36 | | 0.11 | | 0.32 | |
| P×S | | 0.24 | | NS | | 0.25 | | NS | | 0.22 | | NS | | 0.19 | | NS | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $P_1$ | - | PESP | $S_1$ | - | 1°C | P | - | Packing material |
| $P_2$ | - | PETP | $S_2$ | - | 4°C | S | - | Storage temperature |
| $P_3$ | - | PPMM | $S_3$ | - | 8°C | P×S | - | Interaction between packing material and storage temperature |
| | | | $S_4$ | - | Room temperature | * | - | Decayed arils |